2.0 INTRODUCTION

A number of hydrophobic pesticides, including organochlorine and synthetic pyrethroid pesticides, have been and continue to be used in agriculuture in the Central Valley. Based on the Department of Pesticide Regulation (DPR) Pesticide Use Report, between 2000 and 2005, synthetic pyrethroid pesticides use in agriculture in Stanislaus, Merced and San Joaquin Counties has shown a 24% increase. Due to their affinity to adhere to solids and organics in the water column and/or bed sediments, water column chemical and toxicity testing is not well suited to detect these types of hydrophobic compounds, and there is concern that these compounds are accumulating in depositional sediment in low gradient Central Valley water bodies.

Beginning in October 2001, The Central Valley Regional Water Quality Control Board (CVRWQCB) began sediment sampling in tributaries to the San Joaquin River (SJR) and the Sacramento-San Joaquin Delta (Delta) for toxicity to the amphipod *Hyalella azteca* (*H. azteca*). The sediment sampling effort was closely coordinated with the CVRWQCB Organophospate Total Maximum Daily Load (OP TMDL) bioassessment, Irrigated Lands Program and Surface Water Ambient Monitoring Program (SWAMP) programs, the Department of Pesticide Regulation (DPR), as well as University of California campuses, Berkeley and Davis. The analysis of sediment samples was facilitated through funding from the SWAMP and OP TMDL.

The sediment toxicity testing focused on the agricultural dominated valley floor of the SJR Basin, where pyrethroid pesticide use is increasing. The objectives of this sediment toxicity project were to determine if sediment toxicity was evident in the SJR Basin, identify areas with persistent sediment toxicity, and attempt to identify the causes of identified toxicity.

3.0 STUDY AREA

The San Joaquin River (SJR) is the principal drainage artery of the San Joaquin Valley. The basin covers 17,720 square miles (Basin Plan, 2002) and yields an average annual surface runoff of about 1.6 million-acre feet. The SJR basin drains the portion of the Central Valley south of the Sacramento-San Joaquin Delta and north of the Tulare Lake Basin.

The river flows westward from the Sierra Nevada and turns sharply north at Mendota Pool near the town of Mendota. Most of the SJR flow is diverted into the Friant-Kern Canal, leaving the river channel upstream of the Mendota Pool dry except during periods of wet weather flow and major snow melt. The river continues past Mendota Pool to form a broad flood plain, as it turns northward, for a distance of approximately 50 miles until the river is narrowed by the constrictions of the Merced River and Orestimba Creek alluvial fans.

Flows from the east side of the river basin to the San Joaquin River are dominated by discharges from the Merced, Tuolumne, and Stanislaus Rivers, which primarily carry snowmelt from the Sierra Nevada. Flows from the west side of the river basin are dominated by agricultural return flows, since west side streams are ephemeral and their downstream channels are used to transport agricultural return flows to the main river channel during the irrigation season.

The principal streams in the basin are the San Joaquin River and its larger tributaries: the Cosumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, Chowchilla, and Fresno Rivers, which all drain the east side of the basin. Major land use along the San Joaquin Valley floor is agricultural, with over 2.1 million irrigated acres, representing 22% of the irrigated acreage in California. Return flows from agricultural operations drain to the SJR via ephemeral streams and constructed channels, and ultimately reach the Sacramento-San Joaquin Delta.

4.0 SAMPLING PROGRAM

4.1 Sampling Locations and Frequency

Sediment Samples were collected from sites tributary to the SJR and the Delta from October 2001 through September 2005. The majority of sampling occurred October 2001 through April 2003 in Stanislaus, Merced, and San Joaquin Counties. Specific targeted sampling and funding of toxicity identification evaluations (TIEs) occurred after April 2003. A complete sampling matrix is listed in Table 3 and outlines when specific sites were sampled. Sediment sampling was closely coordinated with monitoring conducted by the Central Valley Regional Water Quality Control Board (CVRWQCB) OP TMDL, CVRWQCB Irrigated Lands and Surface Water Ambient Monitoring Program (SWAMP) Programs as well as the Department of Pesticide Regulation (DPR) and University of California campuses, Berkeley and Davis. Additional background information on each site can be found on the CVRWQCB SWAMP website at: http://www.waterboards.ca.gov/centralvalley/programs/agunit/swamp/sjr_swamp.html.

Sampling locations were selected based on existing SWAMP sampling locations in the SJR Basin. The SWAMP effort divided the SJR Basin into six sub basins: Northeast, Eastside, Westside, Southeast, Grassland, and Delta Basins based on similar geography and hydrology with representative trend monitoring sites for each. The majority of sampling sites for this project focused on the long term trend sites within three sub-basins (Eastside, Northeast, and Westside) where water quality sampling occurred monthly between October 2001 and October 2005. Additional sites included SWAMP sites monitored during more intensive rotational sampling and a special study on agriculture inflow coordinated with DPR. A summary of the total number of samples in each sub-basin can be found in Table 1. Individual sites are listed in Table 2 and depicted in Figure 1. Sample collection dates for sediment toxicity testing for each site are listed in Table 3.

Table 1. Total number of sediment toxicity samples collected in each SJR sub-basin.

SJR Sub-basin	Total # of samples
Delta	3
DPR Study (Delta)	12
Eastside	17
Grassland	12
Northeast	9
Westside	20
Total	73

In addition, after April 2003 specific areas with known pyrethroid use were targeted due to the increased associations of this class of pesticide and the potential for sediment toxicity. This targeting included sediment collected for TIEs, sediment toxicity testing for a DPR study at Mid Roberts Island in the Delta, and an upstream study for Del Puerto Creek.

Table 2. Sampling Site Information for the San Joaquin River Basin Sediment Toxicity Project.

Site Location	Site Code	SJR Sub-basin	Latitude	Longitude
Mt. House Creek at Mt. House Parkway	SJC509	Delta	37.78556	-121.53472
Bear Creek at Lower Sacramento Rd.	SJC515	Delta	38.04278	-121.32139
Unnamed Canal at Howard Rd.*	SJC516	Delta	37.87696	-121.37656
Mid Roberts Island Drain at Woodsbro Rd.*	SJC517	Delta	37.94163	-121.3693
Bear Creek near Bert Crane Rd.	MER007	Eastside	37.25556	-120.65194
Merced River at River Rd.	MER546	Eastside	37.34972	-120.95778
Ingalsbe Slough at J17 Turlock Rd.	MER579	Eastside	37.49167	-120.55778
Lone Tree Creek at Austin Rd.	SJC503	Eastside	37.85556	-121.185
French Camp Slough at Airport Way	SJC504	Eastside	37.88167	-121.24944
Calaveras River at Hwy 88	SJC513	Eastside	38.05139	-121.18778
Lone Tree Creek at Escalon-Belota Rd.	SJC531	Eastside	37.8222	-120.9973
TID 5 Harding Drain at Carpenter Rd.	STC501	Eastside	37.46444	-121.03028
Salt Slough at Lander Ave.	MER531	Grassland	37.24861	-120.85111
Mud Slough Upstream of SLD Terminus	MER536	Grassland	37.25417	-120.90694
Mud Slough at San Luis Drain	MER542	Grassland	37.26389	-120.90611
Sutter Creek at Hwy 49	AMA002	Northeast	38.3925	-120.80139
N. Fork Calaveras River at Gold Strike Rd.	CAL003	Northeast	38.22611	-120.69972
Calaveras River at Monte Vista Trailhead	CAL008	Northeast	38.14833	-120.82556
Cosumnes River at Hwy 49	ELD004	Northeast	38.55083	-120.84972
Mokelumne River at New Hope Rd.	SAC002	Northeast	38.23611	-121.41889
Cosumnes River at Michigan Bar Rd.	SAC003	Northeast	38.50056	-121.045
Mokelumne River at Van Assen Co. Park	SJC512	Northeast	38.22278	-121.03472
Orestimba Creek at River Rd.	STC019	Westside	37.41389	-121.01417
Westly Wasteway near Cox Rd.	STC029	Westside	37.55553	-121.16824
Grayson Road Drain at Grayson Rd.	STC030	Westside	37.56194	-121.17417
Ingram Creek at River Rd.	STC040	Westside	37.60028	-121.22417
Hospital Creek at River Rd.	STC042	Westside	37.61056	-121.22861
Del Puerto Creek at Vineyard Ave.	STC516	Westside	37.52139	-121.14861
Del Puerto Creek 100 ft. upstream of Vineyard Ave.	STCDP1	Westside	37.52009	-121.14860
Del Puerto Creek at Hwy 33	STC523	Westside	37.5138	-121.15986
Del Puerto Creek at Rogers Rd.	STC524	Westside	37.49919	-121.17651
Del Puerto Creek near Cox Rd.	STC533	Westside	37.5313	-121.13805

* DPR Study Sites

Figure 1. San Joaquin River Basin Sediment Toxicity Project Sampling Locations.

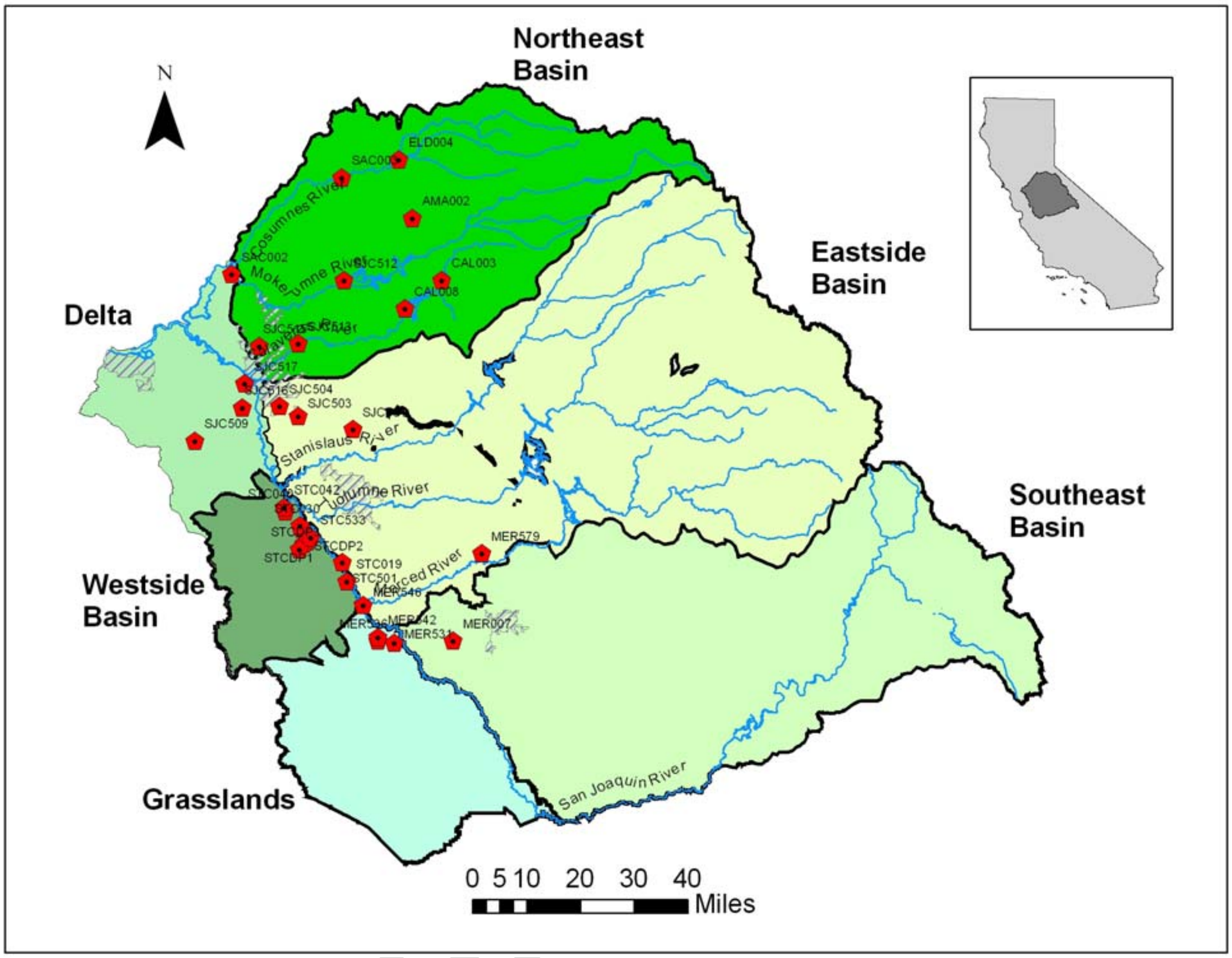


Table 3. Sampling Matrix for the San Joaquin River Basin Sediment Toxicity Project for Sediment toxicity testing only.

Site code	SWAMP SJR Sediment Sampling Site	SJR Sub-basin	Sampling Date													
			10/9/01	5/28/02	5/29/02	5/31/02	9/17/02	9/18/02	9/19/02	9/24/02	10/28/02	4/8/03	4/9/03	7/15/03	11/13/03	6/15/05
SJC509	Mtn. House creek @ Mt. House Prky.	Delta	Dry		Dry					X						
SJC515	Bear Creek at Lower Sacramento Rd.	Delta			X			X								
MER007	Bear Creek @ Bert Crane Rd.	Eastside	X	X			X					X				
MER546	Merced River at River Rd.	Eastside		X												
MER579	Ingalsbe Slough at J17 Turlock Rd.	Eastside		X			X									
SJC503	Lone Tree Cr. @ Austin Rd.	Eastside	X		X			X					X			
SJC504	French Camp Slough @ Airport Way	Eastside			X			X					X			
SJC513	Calaveras R. @ 88	Eastside			Dry			X								
STC501	TID Lateral 5 (Harding Drain)	Eastside	X									X				
MER542	Mud Slough Down stream of SLD	Grassland	X				X					X				
MER531	Salt Slough @ Lander Ave.	Grassland	X	X					X			X				
MER536	Mud Slough up stream of SLD	Grassland	X	X			X					X				
AMA002	Sutter Creek @ Hwy 49	Northeast				X										
CAL003	North Fork Calaveras at Gold Strike Rd.	Northeast				X										
CAL008	Calaveras River @ Montyvista trail head	Northeast				X										
ELD004	Cosumnes River @ Hwy 49	Northeast				X										
SAC002	Mokelumne @ New Hope Rd.	Northeast						X					X			
SAC003	Cosumnes R @ Michigan Bar	Northeast	X		X	X										
SJC512	Mokelumne River @ Van Assen Co. Park	Northeast														
STC019	Orestimba Creek @ River Rd.	Westside	X		X				X			X				
STC030	Grayson Drain	Westside							X				X	X		X
STC040	Ingram Cr. @ River Rd.	Westside								X			X	X	X	
STC516	Del Puerto Creek @ Vineyard	Westside	X		X						X		X			X
STCDP1	Del Puerto Creek 100 ft upstream of Vineyard	Westside									X					
STC523	Del Puerto Creek @ Hwy 33	Westside									X					
STC524	Del Puerto Creek @ Rogers Rd.	Westside									X					

4.2 Field Methods

Sediment samples were collected according to protocols outlined in the SWAMP Quality Assurance Management Plan (QAMP) using clean technique (Puckett M., April 2002). Samples were collected by scooping, with a clean plastic scoop, the top 5-cm. of recently deposited fine sediment and transferring that sediment into a clean glass 4-Liter composite jar. Large rocks, leaves and sticks were removed before compositing. The sample was mixed until homogenized and placed into two 1-Liter plastic jars for toxicity testing, one 250-ml glass container for Enzyme-Linked Immunosorbant Assay (ELISA), two 250-ml clear glass containers for grain size and total organic carbon (TOC) tests, and two 250-ml amber glass containers for archives. After July of 2003, all toxicity and toxicity identification evaluation (TIE) samples were collected into two or more separated liter glass containers. More details on sampling methodology can be found in the SWAMP QAMP located at http://www.swrcb.ca.gov/swamp/qamp.html.

Once collected, composited, and transferred to appropriate containers, samples were immediately labeled and placed on ice (<4°C) and in a dark location until shipment to the analyzing laboratory. Toxicity, ELISA, and TIE samples were analyzed by the University of California at Davis, Marine Pollution Studies Laboratory (MPSL) in Monterey, California. Grain size and TOC samples were analyzed by Applied Marine Sciences, Inc (AMS), in League City Texas, and archives were sent to Moss Landing Marine Laboratories (MLML), Moss Landing California, or the CVRWQCB Laboratory to be stored for one year from the date of collection. Samples collected for chemical analysis, were analyzed by, the Department of Fish and Game Water Pollution Control Laboratory (DFG WPCL) in Rancho Cordova, California.

4.3 Laboratory Methods

All laboratory tests were performed according to methods outlined in the SWAMP QAMP. Ten-day *Hyalella azteca* toxicity tests were performed according to methods outlined in the SWAMP QAMP as well as the MPSL: *Overview of Fresh and Marine Toxicity Tests for Hazard Assessment in California Waters* (Anderson B. et. al, 2001). ELISA tests followed methods supplied from Strategic Diagnostics Inc, Newark Delaware. Grain size was measured using U.S. standard sized sieves and protocol ASTM D422; TOC was measured using EPA method 9060. TIE methods follow EPA Phase I-III methods (EPA 600/6-91/003, EPA 600/R-92/080 and EPA 600/R-92-081), as well as others developed by MPSL and can be found in the SWAMP QAMP (Personal communication, Phillips B., January 2002). Pesticide scans in sediment and porewater were performed using EPA approved methods for pyrethroid (EPA Method 1660) Organochlorine (EPA Method 8081) and Organophosphate pesticides (EPA Method 8141A).

5.0 DATA ANALYSIS CRITERIA

Data were analyzed and assigned a toxicity category. This assignment was based on if a sample met two criteria and is consistent with the SWAMP designation of toxicity. The first criterion uses a statistical test to determine if the environmental sample is statistically significant compared to the control. The second criterion reviews the percent survival versus an 80% survival target. The less than 50% survival criteria for “highly toxic” category is consistent with the 50% survival trigger for TIE analysis utilized by the Central Valley Regional Water Quality Control Board’s Irrigated Lands Program. Using the two criteria outlined above, samples were then assigned toxicity categories of nontoxic, toxic, and highly toxic (Table 4). It is possible for a sample to show survival less than 80%, and still not be considered significantly compared to the control. In this case, the mean survival when compared to the control was above 80% and deemed not significant. These samples were assigned the “nontoxic” category.

Table 4. Criteria used for Assigning Toxicity Categories

Toxicity Category	Criteria
Nontoxic	Not significant toxicity compared to the control and *H. azteca* survival greater than or equal to 80%.
Toxic	Significant toxicity compared to the control and *H. azteca* survival between 50% and less than 80%.
Highly toxic	Significant toxicity compared to the control and *H. azteca* survival less than 50%.

6.0 RESULTS

6.1 Sediment Toxicity

Statistically significant toxicity to *H. azteca* occurred in 19 of 73 samples (26%) collected during the project. All sediment toxicity testing results are listed in Appendix A-1 and summarized in Table 6. The Delta, Northeast, and Grassland sub-basins survival was categorized as nontoxic and ranged from 76.25% to 100%, although the Delta sub-basin was not as thoroughly sampled as other sub-basins. The Eastside sub-basin had 1 sample with statistically significant toxicity (60% survival) out of 17, with the remaining survival rates ranging from 76% to 98%.

The majority of mortality to *H. azteca* occurred in water bodies located in the Westside sub-basin. Sediment was collected at 7 locations in the Westside sub-basin totaling 20 samples. Toxicity to *H. azteca* was found in 18 of the 20 samples (90%) collected in the Westside sub-basin and ranged from 0% to 86% survival. Samples that showed toxicity ranged from 0% to 65% survival, with 13 out of the 18 toxic samples having less than 50% survival and categorized as highly toxic. Of the Westside sub-basin sites sampled on multiple occasions, 3 sites showed toxicity at each sampling event: Del Puerto Creek at Vineyard Road (STC516) survival ranged from 0% to 61%;Ingram Creek at River Road (STC040) survival ranged from 0% to 55.1%; and Grayson Road Drain at Grayson Road (STC030) survival ranged from 0% to 58%.

6.2 Sediment Particle Size and Total Organic Carbon

The amount of silt and clay found in sediment samples collected ranged from 3% to 98% of the sample. Sediment collected in the Delta and Westside sub-basins contained the largest average amount of silt and clay at 74% and 68%, respectively. Samples collected in the Northeast sub-basin averaged the least amount of silt and clay at 17%.

In addition to sediment particle size, total organic carbon (TOC) found in sediment samples was analyzed. The highest average TOC was found in the Delta sub-basin at 1.47%. The highest amount of TOC was found in a sample collected in the Northeast sub-basin at 4.3%. A summary of the range and mean of fine particle size and TOC for each sub-basin is listed in Table 5.

Table 5. Range and Mean for Fine Particle Size and TOC.

SJR Sub-basin	Total Silt & Clay (%)			TOC (%)		
	Low	High	Mean	Low	High	Mean
Delta	40.4	98.26	74.44	0.51	2.72	1.47
Eastside	11.63	79.04	34.18	0.21	3.36	0.95
Grassland	18.15	80.38	45.25	0.26	1.41	0.62
Northeast	3.24	67.14	17.55	0.18	4.3	0.98
Westside	46.62	94.66	68.35	0.15	2.3	0.83

Table 6. Summary of Sediment Toxicity Testing Mean Survival Results.

Site Code	Site Name	SJR Sub-basin	Sample Date												# Times Sampled	# Toxicity Hits
			1-Oct	2-May	2-Sep	2-Oct	3-Apr	3-Jul	3-Nov	4-Mar	4-Jun	5-Mar	5-Jun	5-Sep		
SJC509	Mt. House Creek at Mt. House Parkway	Delta	D	D	86										1	0
SJC515	Bear Creek at Lower Sacramento Rd.	Delta		100	96										2	0
SJC516	Unnamed Canal at Howard Rd.*	Delta					86.25			96	94	90	90	92.5	6	0
SJC517	Mid Roberts Island Drain at Woodsbro Rd.*	Delta					87.5			94	93	95	89	95	6	0
MER007	Bear Creek near Bert Crane Rd.	Eastside	93	96	78		92.5								4	0
MER546	Merced River at River Rd.	Eastside		98											1	0
MER579	Ingalsbe Slough at J17 Turlock Rd.	Eastside		98	83										2	0
SJC503	Lone Tree Creek at Austin Rd.	Eastside	91	83	84		91.25								4	0
SJC504	French Camp Slough at Airport Way	Eastside		96	88		76.25								3	0
SJC513	Calaveras River at Hwy 88	Eastside		D	76										1	0
STC501	TID 5 Harding Drain at Carpenter Rd.	Eastside	83				60								**2**	**1**
MER531	Salt Slough at Lander Ave.	Grassland	89	93	91		90								4	0
MER536	Mud Slough Upstream of SLD Terminus	Grassland	93	96	93		77.5								4	0
MER542	Mud Slough at San Luis Drain	Grassland	88	98	95		77.5								4	0
AMA002	Sutter Creek at Hwy 49	Northeast		98											1	0
CAL003	N. Fork Calaveras River at Gold Strike Rd.	Northeast		98											1	0
CAL008	Calaveras River at Monte Vista Trailhead	Northeast		78											1	0
ELD004	Cosumnes River at Hwy 49	Northeast		99											1	0
SAC002	Mokelumne River at New Hope Rd.	Northeast			89		93.75								2	0
SAC003	Cosumnes River at Michigan Bar Rd.	Northeast	79	96											2	0
SJC512	Mokelumne River at Van Assen Co. Park	Northeast		85											1	0
STC019	Orestimba Creek at River Rd.	Westside	65	86	41		55								**4**	**3**
STC030	Grayson Road Drain at Grayson Rd.	Westside			58		0	17.8					38		**4**	**4**
STC040	Ingram Creek at River Rd.	Westside			0		18.75	55.1	2.5						**4**	**4**
STC516	Del Puerto Creek at Vineyard Ave.	Westside	0	61		5	37.5						39		**5**	**5**
STCDP1	Del Puerto Creek 100 ft. upstream of Vineyard Ave.	Westside				46									**1**	**1**
STC523	Del Puerto Creek at Hwy 33	Westside				79									1	0
STC524	Del Puerto Creek at Rogers Rd.	Westside				33									**1**	**1**

Red highlight = highly toxic, Yellow highlight = toxic, D = Dry, * = DPR study sites

7.0 ADDITIONAL STUDIES

Specific areas with known pyrethroid use were targeted due to the increased associations of this class of pesticide and the potential for sediment toxicity. This targeting included sediment collected for specific pesticide analysis, Toxicity Identification Evaluations (TIEs) for sites demonstrating chronic sediment toxicity, and an upstream study for Del Puerto Creek. In addition, CVRWQCB staff participated in a Department of Pesticide Regulation (DPR) study at Mid Roberts Island in the Delta, which included bioassessment and water column analyses in addition to analyzing sediment collected for toxicity at 6 sampling events and pyrethroids at 1 sampling event.

7.1 Pesticide Analysis

Select sediment samples were analyzed for the pesticides chlorpyrifos and diazinon, with the majority of samples collected located in the Westside sub-basin. Chlorpyrifos was detected in 5 of 40 samples with concentrations ranging from 1.67 to 9.2 ng/g. Diazinon was detected in 6 of 40 samples with concentrations ranging from 1.23 to 4.7 ng/g. The complete results for organophosphate pesticides for each sampling event can be found in Appendix A-3. Table 7 summarizes detectable results for chlorpyrifos and diazinon.

Table 7. Samples with Detections of Chlorpyrifos or Diazinon.

Site Code	Site Name	SJR Sub-basin	Sample Date	Chlorpyrifos (ng/g)	Diazinon (ng/g)
STC516	Del Puerto Creek at River Rd.	Westside	5/29/02	5.6	4.7
STC019	Orestimba Creek at River Rd.	Westside	9/19/02	ND	3.7
STC501	TID 5 Harding Drain at Carpenter Rd.	Eastside	4/8/03	1.82	2.26
STC030	Grayson Road Drain at Grayson Rd.	Westside	4/9/03	6.18	1.26
STC040	Ingram Creek at River Rd.	Westside	4/9/03	1.67	1.23
STC516	Del Puerto Creek at River Rd.	Westside	4/9/03	9.20	1.23

ND = Not detected

In addition to Chlorpyrifos and Diazinon, select sediment samples were analyzed for pyrethroid pesticides at 3 sampling events (10/28/2002, 6/15/2005, and 9/19/2005). Pyrethroids were detected in 5 out of 11 samples, with bifenthrin detected in 4 of those samples. Cypermethrin was detected at Del Puerto Creek at Vineyard Avenue (STC516), but was detected at levels below the reporting limit. Table 8 lists all detectable pyrethroid pesticide findings. The complete results for pyrethroid pesticides for each sampling event can be found in Appendix A-2.

Table 8. Samples with Detections of Pyrethroid Pesticides.

Site Code	Site Name	Sample Date	Bifenthrin (ng/g)	Cypermethrin - 1 (ng/g)	Cypermethrin - 3 (ng/g)	Lamda-cyhalothrin - 2 (ng/g)
STC516	Del Puerto Creek at Vineyard Ave.	10/28/2002	7.51	NA	NA	ND
SJC504	French Camp Slough at Airport Way	6/15/2005	1.02	ND	ND	ND
STC516	Del Puerto Creek at Vineyard Ave.	6/15/2005	ND	1.85*	2.03*	ND
SJC504	French Camp Slough at Airport Way	9/19/2005	2.44	ND	ND	2.19
SJC531	Lone Tree Creek at Escalon-Belota Rd.	9/19/2005	1.64	ND	ND	ND

* = Pesticide detected at levels below reporting limit, ND = Not detected, NA = Not analyzed

7.2 Toxicity Identification Evaluations

Due to the frequent sediment toxicity found in the Westside sub-basin in previous sampling events, specific sites were targeted to evaluate the potential cause of toxicity. In all sediment samples where a toxicity identification evaluation (TIE) was conducted, *H. azteca* mortality was significant (categorized as highly toxic) with complete mortality in 6 out of 8 samples. Lines of evidence for the majority of TIEs indicated pyrethroids as the likely cause of toxicity. Table 10 (found on page 12) summarizes the results of the TIEs conducted during the project. Complete TIE results for each sampling event can be found in Appendix B.

7.3 Del Puerto Creek Upstream Study

Due to the frequent sediment toxicity found in Del Puerto Creek at Vineyard Road (STC516), an upstream study was completed on 28 October 2002, to assess if pesticides were present and determine the extent of the sediment toxicity upstream of STC 516 (Figure 2). Samples were collected at Del Puerto Creek at Vineyard Road (STC 516), 100 feet upstream of Del Puerto Creek at Vineyard Road (STCDP1), Del Puerto Creek at Highway 33 (STC DP2), and Del Puerto Creek at Rogers Road (STCDP3). Sediment toxicity was categorized as highly toxic at 3 of the 4 sites sampled (STC516, STCDP1, and STCDP3). Bifenthrin was detected at Del Puerto Creek at Vineyard Avenue (STC516) at a concentration of 7.5 ng/g, while the sediment toxicity resulted in a 5% survival of *H. azteca* (categorized as highly toxic). In addition to pyrethroids, sediment samples were analyzed for Chlorpyrifos and Diazinon and neither pesticide was detected. The results of the Del Puerto Creek Upstream Study are summarized in Table 9.

Table 9. Del Puerto Creek Upstream Sediment Study Results: 28 October 2002.

Site Code	Site Name	% Survival	Bifenthrin (ng/g)	Lambda-cyhalothrin (ng/g)	Permethrin (ng/g)	Cyfluthrin (ng/g)	Esfenvalerate (ng/g)	Fenvalerate (ng/g)
STC516	Del Puerto Creek at Vineyard Ave.	5	7.51	ND	ND	ND	ND	ND
STCDP1	Del Puerto Creek 100 ft. upstream of Vineyard Ave.	46	<RL*	ND	ND	<RL*	ND	ND
STC523	Del Puerto Creek at Hwy 33	79	ND	ND	ND	ND	ND	ND
STC524	Del Puerto Creek at Rogers	33	ND	ND	ND	ND	ND	ND

ND = not detected, <RL* = detected at less than the reporting limit.

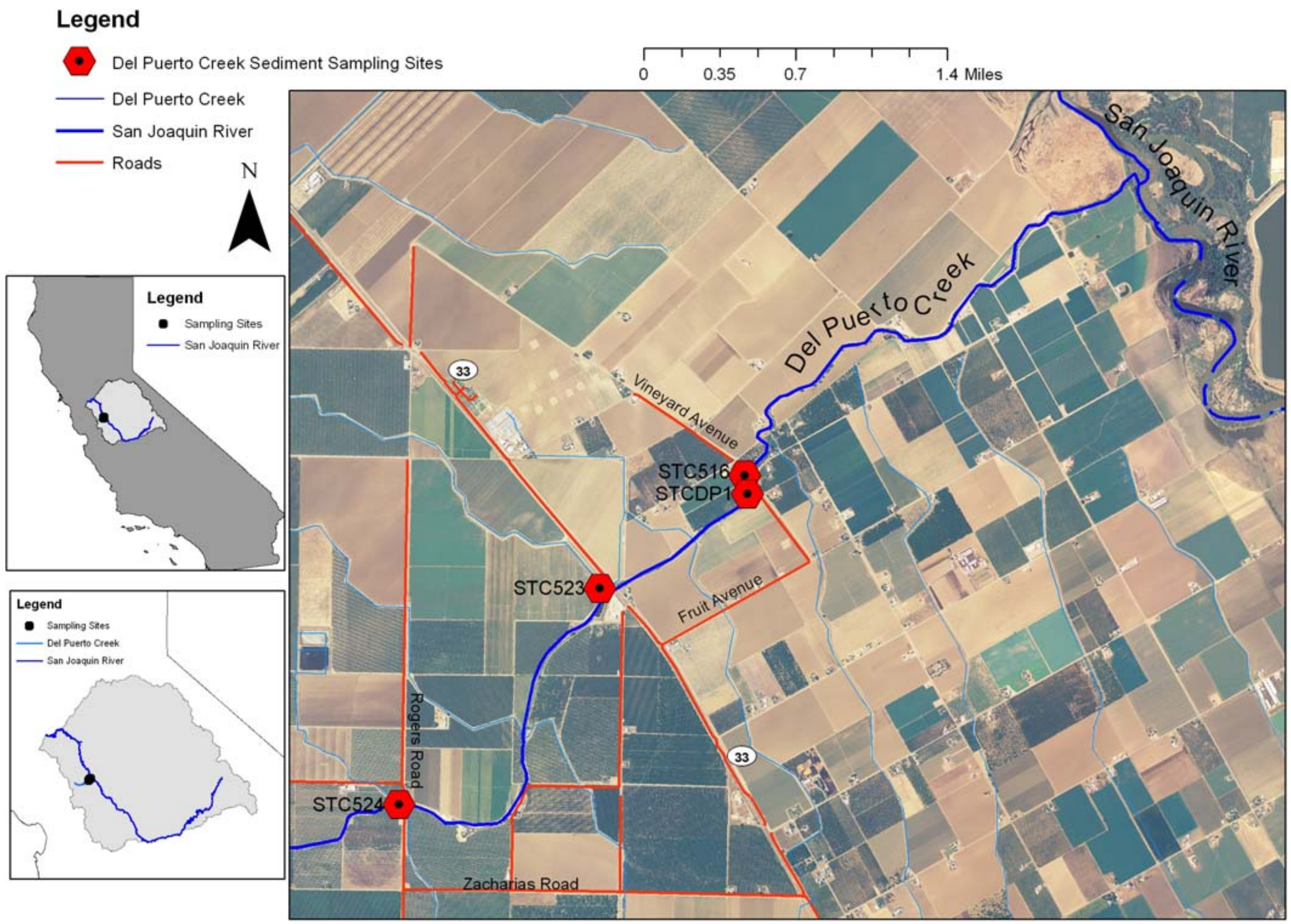
Table 10. Summary of Sediment Toxicity Results and Select Chemical Analysis for Each TIE.

Site Code	Site Name	Sampling Date	% Survival	Chlorpyrifos (ng/g)	Total DDT (ng/g)	Bifenthrin (ng/g)	Cyfluthrin (ng/g)	Cypermethrin (ng/g)	Esfenvalerate/ Fenvalerate (ng/g)	Lamda Cyhalothrin (ng/g)	Permethrin (ng/g)	Likely Cause of Toxicity[1]
STC516	Del Puerto Creek at Vineyard Road	5/29/02	0	NA	NA	NA	NA	NA	NA	NA	NA	Pyrethroids[2]
STC516	Del Puerto Creek at Vineyard Road	9/11/02	0	NA	56.85	43.2	NA	NA	NA	NA	20.4	Pyrethroids
STC040	Ingram Creek at River Road	11/13/03	0	NA	NA	NA	NA	NA	NA	NA	NA	Organic contaminants[2]
STC040	Ingram Creek at River Road	9/13/04	0	NA	NA	ND	3.21	ND	5.47	25.2	ND	Pyrethroids
STC042	Hospital Creek at River Road	3/30/05	22	NA	57.74	NA	NA	NA	0.32	0.18	NA	DDT and pyrethroids (smaller role)
STC030	Grayson Road Drain at Grayson	6/15/05	10	10.7	181.41	NA	NA	NA	NA	NA	NA	Chlorpyrifos and DDT
STC029	Westly wasteway near Cox Road	10/10/05	0	NA	67.1	5.08	NA	NA	ND	113.7	ND	Pyrethroids
STC533	Del Puerto Creek near Cox Road	10/10/05	0	NA	58.9	58.6	NA	NA	1.09	2.56	4.92	Pyrethroids

NA = not analyzed, ND = not detected

[1] Results from UC Davis TIEs found in Appendix B.
[2] TIE treatments (PBO, C-18 column, temperature, pH, etc.) indicated organic contaminants or pyrethroids. TIEs found in Appendix B.

Figure 2. Sampling locations for the Del Puerto Creek Upstream Study.



7.4 Roberts Island

The Department of Pesticide Regulation (DPR) collaborated on a study to identify potential adverse impacts to the aquatic environment from pesticides by characterizing the benthic macroinvertebrate community of agricultural impacted waters and comparing them to similar ones that are not impacted, or less so. A secondary goal of the study was to characterize pesticide concentrations in surface waters in areas of high agricultural use. (DPR Report # EH06-01) A small portion of the overall project focused on potential impacts from drainage of a diversified agricultural area by evaluating conditions upstream (supply water) and downstream (mixed supply and drainage) of discharge. CVRWQCB staff deployed YSI Sondes to collect pH, electrical conductivity, dissolved oxygen, temperature, and turbidity data for the cooperative study. In addition, CVRWQCB staff collected sediment samples at six sampling events between April 2003 and September 2005. During each sampling event two sites were monitored, Unnamed Canal at Howard Road (SJC516) upstream; and Mid Roberts Island Drain at Woodsbro Road (SJC517) downstream. Mean percent survival of *H. azteca* ranged from 86.25 to 95 for all sediment samples collected for this study. The complete sediment toxicity results are listed in Appendix A-1. The 19 September 2005 sampling event included pyrethroid pesticides and resulted in no detections of pyrethroids. The complete pyrethroid pesticide results are found in Appendix A-2. A full review of the overall study is provided in the DPR report.

8.0 SUMMARY/DISCUSSION

This study evaluated sediment collected in the San Joaquin River (SJR) Basin for toxicity to *H. azteca*. The high gradient sites proved difficult to sample effectively for sediment toxicity analysis due to large sediment grain sizes and absence of recently deposited fines. These high gradient site samples lacked the clays and organic carbon, which are binding agents for most organic pollutants. Due to these initial findings, the majority of sampling occurred in the agricultural dominated valley floor of the SJR Basin. Samples were collected in five out of the six sub-basins, identified in the SWAMP SJR Basin Program. The majority of sampling sites for this Sediment Toxicity Project focused on the long term trend sites within three sub-basins (Eastside, Northeast, and Westside) where sampling occurred between October 2001 and October 2005.

Sediment toxicity was more prevalent in the Westside sub-basin. Toxicity to *H. azteca* occurred in 18 out of 20 samples (90%) in the Westside sub-basin, with the majority categorized as highly toxic (<50% survival). Select Westside sub-basin sediment samples were analyzed for pesticides, resulting in detections of bifenthrin, chlorpyrifos, and diazinon. In addition, Toxicity Identification Evaluations (TIEs) were completed on samples collected from Westside sub-basin sites to identify causes of toxicity. Lines of evidence in the majority of TIEs (5 out of 8) indicated pyrethroids as the main cause of toxicity in the sediment samples. Remaining causes of toxicity were identified as chlorpyrifos, organic compounds, DDT, and/or a combination. Table 11 combines mean survival of *H. azteca* for all sediment toxicity testing and TIEs for the Westside sub-basin sites.

Table 11. Mean survival of *H. azteca* for all Westside sub-basin samples, including TIE toxicity results.

Site Code	Site Name	Sample Date																	# Times Sampled	# Toxicity Hits
		10/9/01	5/29/02	5/29/02*	9/11/02	9/19/02	9/24/02	10/28/02	4/8/03	4/9/03	7/15/03	11/13/03	11/13/03*	9/13/04	3/30/05	6/15/05	6/15/05*	10/10/05		
STC019	Orestimba Creek at River Rd.	65	86			41			55										**4**	**3**
STC029	Westly Wasteway near Cox Rd.																	0	**1**	**1**
STC030	Grayson Road Drain at Grayson Rd.					58				0	17.8					38	10		**5**	**5**
STC040	Ingram Creek at River Rd.						0			18.75	55.1	2.5	0	0					**6**	**6**
STC042	Hospital Creek at River Rd.														22				**1**	**1**
STC516	Del Puerto Creek at Vineyard Ave.	0	61	0	0			5		37.5						39			**7**	**7**
STCDP1	Del Puerto Creek 100 ft. upstream of Vineyard Ave.							46											**1**	**1**
STC523	Del Puerto Creek at Hwy 33							79											1	0
STC524	Del Puerto Creek at Rogers Rd.							33											**1**	**1**
STC533	Del Puerto Creek near Cox Rd.																	0	**1**	**1**

* Sediment samples collected for both sediment toxicity analysis and TIEs.
Red highlight = highly toxic, Yellow highlight = toxic

Weston et. al. (2004), found similar toxicity results on sites they sampled during the same time period of this project. Weston et. al. (2004) sampled Del Puerto Creek in August of 2002 and found 78% mortality (22% survival). In addition, Weston sampled Orestimba Creek in September 2002 and found 58% mortality (42% survival). The evidence suggested that pyrethroids were the likely cause of the high mortality observed. Results for these two sites sampled by Weston et. al. (2004) were consistent with the toxicity results observed for this project.

Pyrethroids were detected during the current project, using both chemical analysis and TIEs. Amweg et al. (2005) reported that pyrethroids, except permethrin, would cause 50% mortality to *H. azteca* at concentrations ranging between 2 to 10 ng/g. A TIE completed at Westly Wasteway near Cox Road (Appendix B-6) in October 2005 resulted in lamda-cyhalothrin detected at 113.7 ng/g, which corresponded to 31.1 toxic units (Marine Pollution Studies Laboratory, 2005). Multiple other TIEs reported concentrations of pyrethroids at levels above the LC 50s for the detected compounds (see Appendix B-1, B-3), although other compounds were identified as the likely cause of toxicity (DDT, chlorpyrifos, and organic contaminants in 3 out of 8 TIEs).

In addition, a Del Puerto Creek Upstream Study detected bifenthrin at the Del Puerto Creek at Vineyard Avenue (STC516) site at a concentration of 7.51 ng/g (bifenthrin LC 50 is 12.9 ng/g). Even though toxicity was detected at the remaining three sites sampled (survival ranging from 33-79%) none of the six pyrethroids included in the scan were detected. With the limited chemical analyses and TIEs conducted during this project, cause of the majority of toxicity identified in this project is not known.

9.0 CONCLUSION

Understanding the effect pyrethroids have on the sediment environment is critical especially with the increase use of these pesticides in the Central Valley. Areas with finer sediments and organics have the potential to accumulate pyrethroids at toxic levels. Out of 24 toxic samples, additional analysis in 9 samples (chemical analyses and TIEs) indicated pyrethroids, DDT, organic contaminants, and/or a combination of these compounds were responsible for the toxicity. Due to limited chemical analyses and TIEs, the cause of much of the sediment toxicity identified during this project is not known. Follow up studies are recommended to assess the remaining unknown sediment toxicity identified during the project and the impact of pyrethroids not just in the SJR Basin, but also throughout the Central Valley.

Recently a grant has been awarded to UC Berkeley (SWRCB Agreement #06-278-555-0) to determine the cause of unknown sediment toxicity found within the Central Valley. In addition, UC Davis was awarded a grant (SWRCB Agreement #06-152-555-0) to compile available data on pyrethroids and to evaluate any correlations between pyrethroid use and stream concentrations found in the SJR Basin. Final reports for these grant projects are expected in March of 2009. In addition, the Central Valley Regional Water Quality Control Board has included sediment toxicity analysis as part of it's Irrigated Lands Program Monitoring and Reporting Program with follow-up TIEs for samples reporting less than 50% survival. These grants and other efforts are critical in assessing the impact pyrethroid pesticides have on sediment quality in the Central Valley.

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